Environmental Gas Laboratory Testing

! This Instruction Contains Descriptions of HAZARDOUS OPERATIONS !

Materials and Processes Laboratory
Materials Test Branch, Building 4623

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Release Authority	Name	Title	Organization	Date
Office of Primary Responsibility	[s] Gail H. Gordon	Materials Test Branch Chief	EM10	11/15/05
	[s] Dennis Davis	Industrial Safety	QD50	11/16/05

Revision	Date	Originator	Description	Affected Pages
Baseline	2/4/05	Eddie Davis	Document converted from ED36-OWI-052. Previous history retained in system as part of canceled or superseded ISO Document files.	All
A	11/17/05	Eddie Davis	Hazardous Operations notification added to cover	Cover, ii

This document baselines the Organizational Work Instruction (OWI) for the Environmental Gas Laboratory for samples submitted for testing in Building 4623 and for samples tested on site. Any change to this OWI shall be submitted to and approved by the Materials Test Branch Chief, EM10. Revisions may be also be submitted to the concurring organizations listed below for review and concurrence by memo. The original OWI and all changes shall be maintained by EM10.

Concurring organizations:
Building 4623 Test Operations Contractor
EM10 COTR
Environmental Health, AD60M

Contents

Document History Log ii

1.0 Scope 1
- 1.1 Scope 1
- 1.2 Purpose 1
- 1.3 Applicability 1

2.0 Applicable Documents 2

3.0 Definitions 4
- 3.1 Definitions 4
- 3.2 Acronyms 5

4.0 Instructions 6
- 4.1 Sample Collection 6
- 4.2 Procedure for Sampling Low-Pressure Points 8
- 4.3 Procedure for Sampling High-Pressure Points 12
- 4.4 Special Sampling Procedure 17
- 4.5 Procedures for Particulate and Moisture Sampling 18
- 4.6 Sample Logging 20
- 4.7 Test Procedures for Gas Analyses 20
- 4.8 NVR Procedures and Analysis 24
- 4.9 Data Recording and Reduction 26

5.0 Notes 28

6.0 Safety Precautions and Warning Notes 29
- 6.1 Hazards 29
- 6.2 Safety Precautions 29
- 6.3 Special Procedures Associated with Compressed Gases and Liquids 30
- 6.4 Emergency Shutdown Procedure 31
- 6.5 Accident Reporting 31
- 6.6 Emergency Response Plan 31
- 6.7 Mishap Reporting 31

7.0 Attachments, Data, Reports, and Forms 33
- 7.1 Attachments 33
- 7.2 Reports 33
- 7.3 Forms 33

8.0 Records 38
- 8.1 Memoranda 38
- 8.2 Calibration Records 38
- 8.3 Maintenance of Records 38

9.0 Tools, Equipment, and Materials 39
- 9.1 Testing Equipment 39
- 9.2 Required Tester Maintenance 39
- 9.3 Calibration 39
- 9.4 Environmental Gas Laboratory Equipment 40

(continued)

Contents (concluded)

10.0 Personnel Training....41
10.1 Low-Pressure Gas Monitoring....42
10.2 High-Pressure Gas Monitoring....42
10.3 Cryogenic Monitoring....43
10.4 Laboratory Analysis of Gasses....44
10.5 Sampling and Laboratory Analysis of NVR Content....44
10.6 Recredentialling....44

Emergency Phone Numbers....46

1.0 Scope

1.1 Scope

The scope of this Organizational Work Instruction (OWI) is the sampling, chemical analysis, and reporting of analytical results of periodically scheduled gas samples. Additionally, the work involves resolving Avoid Verbal Orders (AVO - special order) requests, which include non-routine gas analyses and analysis for Non-Volatile Residue (NVR). The analysis is performed either on site or in the Toxicity Laboratory in Building 4623 at the Marshall Space Flight Center

1.2 Purpose

Environmental Gas Laboratory personnel perform the following tasks, which are outlined in this OWI:

1. Analyses of testing, purge, and pressurized gas systems. A large number of testing, purge, and pressurized gas systems support the development, manufacture, and testing of aerospace vehicles and systems at MSFC. The gases used in these systems include breathing air, nitrogen, helium, and hydrogen. Analysis is performed on these gases and others to certify qualification by various NASA, military, and other specifications.

2. Specially requested non-routine analysis. In addition to the analyses described in Task 1, specially requested non-routine analysis is performed on an as-requested basis (AVOs). These requests are routed through responsible Materials and Processes Laboratory personnel and are fulfilled by Environmental Gas Laboratory personnel.

3. Data Analysis. The analytical data package **shall be completed** by gas laboratory personnel, reviewed by the gas laboratory manager, and reported to the requester in a standard format. Occasionally, verbal results are requested.

1.3 Applicability

This instruction applies to the Chemistry Team, Materials Test Branch, of the Materials and Processes Laboratory.

2.0 Applicable Documents

ANSI/CGA G-7.1, *Air Specification*

ASTM F-312, *Standard Test Methods for: Microscopical Sizing and Counting Particles from Aerospace Fluids on Membrane Filters*.

ASTM F-331-000, *Standard Test Methods for: Nonvolatile Residue of Solvent Extract from Aerospace Components (using Flash Evaporator)*.

CE Instruments GC8000 TOP Series – Instruction Manual Rev. A2-WW-11/96 GG.

Drager Rohrchen *Instructions for Use, 8th Edition, January 1998*.

EM50-OWI-010. *Nonvolatile Residue Content (NVR)*.

EM10-OWI-CHM-CHM-050, *Building 4623 Guidelines for General Operations.*

EM10-OWI-CHM-CHM-058. *Chemical Hygiene Plan for Building 4623*.

Envirolink GC/LC-MS, *Users Manual.* 1994.

Finnigan INCOS XL *Series Systems Operator's Manual*, Vol. 1, 1992.

Gow Mac Instrument Company, *Operating Manual Series 580 GC with Discharge Ionization Detector and 3 Pneumatic Valves.* October 1999.

HP EZChrom Chromatography Data System User's Manual 1st edition. 1998.

MIL-P-27201, *Propellant, Pressurizing Agent, Nitrogen.*

MIL-P-25508, *Propellant, Oxygen.*

MIL-P-27401, *Propellant, Hydrogen*.

MIL-P-27407, *Propellant, Pressurizing Agent, Helium.*

MPD 1840.3. *MSFC Respiratory Protection Program*.

MPR 1040.3. *MSFC Emergency Plan*.

MPR 1840.2. *MSFC Hazard Communications Program*.

MPR 8715.1. *MSFC Safety, Health, and Environmental (SHE) Program*.

MPR 8823.2. *Pressure Systems Guidelines and Certification Requirements.*

MSFC S&E 5340.1, *Control of Contaminants in Test Fluids, Test Fluids Systems and Environmentally Controlled Areas.*

MSFC-PROC-404, *Gases, Drying and Preservation Cleanliness Level and Inspection Methods.*

MSFC-PROC-1831, *The Analysis of Nonvolatile Residue Content (Based on ASTM F-331-72)*.

MSFC-PROC-1832, *Sampling and Analysis of Nonvolatile Residue Content on Critical Surfaces*.

MSFC-SPEC-164B, *Cleanliness of Components for Use in Oxygen, Fuel, and Pneumatic Systems*.

MTI (Microsensor Technology Inc.) *M200 Operations Manual*. Revision 1.3, 1990.

MTI *EZChrom 200 Chromatography Data System Users Manual*. Revision 3.5, 1992.

MWI 3410.1D. *Personnel Certification Program*.

MWI 8621.1A, *Close Call and Mishap Reporting and Investigation Program.*

NSTC Course 0313 *Cryogenics Safety Training Manual*.

NSTC Course 0315 *High Pressure System Safety Training Manual*.

Perkin-Elmer *Autosystem GC/FID Operators Manual.*

Safety in Hydrogen, Oxygen and Nitrogen Systems Manual, Thomas F. Flynn, 1997.

Scientific Software, Inc. *EZ Chrom Chromatography Data System -- Tutorial and User's Guide,* Version 6.8.

Shaw "Award" Dewpoint Meter Instruction Manual Models SADP-S & ADP-Z.

Tekmar 3100 Purge and Trap Concentrator User Manual.

Trace Analytical *RGA5/Kappa-5 Gas Analysis System Operating Manual,* October 11, 1999.

WSI: 09-SW-0011.B. *Oxygen Systems at White Sands Test Facility.*

Note: Always refer to the current revision of each applicable document.

3.0 Definitions

3.1 Definitions

AVO – Avoid Verbal Orders. Non-routine special request gas sample.

Calibration Response Factor – Calibration result obtained by taking the standard concentration in parts per million (ppm) and dividing it into the average area count of three individual sample runs.

Cosmodyne – Stainless-steel container designed for field collection of cryogenic liquids.

Drager tube – Sealed glass tube containing premixed amounts of specified reagents. Used for on-site analysis of gases for parameters such as CO, CO_2, and water vapor.

Flex hose -- Flexible metal tubing used for sampling.

Gas standard – Pressurized gas sealed in a steel container. Typically obtained from an outside vendor with the gas/gases present in a certified concentration.

Gas tight syringe – Syringe designed to inject air samples to an analytical system. Made of borosilicate glass with a Teflon™ plunger to prevent sample contamination and gas leakage.

High-pressure sample cylinder – Type 304 stainless-steel vessel and needle valve. Used to collect pressurized air samples.

High-pressure sample point – A sample point at which gases or cryogenic liquids are above 150 psi; procedures for sampling of high-pressure points require use of a regulating device.

Low-pressure sample point – A sample point at which gases or cryogenic liquids are at or below 150 psi; procedures for sampling low-pressure points normally do not require the technician to use a regulating device. Special low-pressure situations involving gaseous sampling shall require use of a regulating device.

NASA – Marshall Space Flight Center EM10 responsible personnel.

Particle Counter – Laboratory equipment designed for automated measurement of contaminant particles to determine if they are within the correct size range. Contains a pump to sample the air and a laser to determine the particle size.

Point of Contact – The person (or a designated representative) responsible for the sampling point. Refer to the current list of sample points to identify the Point of Contact.

Tagging – Showing testing results on tag cards at a designated location at each testing point so the requestor can go to a specific clean room or flow bench to view results of the data.

Test engineer – The person responsible for correctly following the approved test plan for a specific test from sample receipt to test data evaluation.

Test operator – The person responsible for conducting the test under the guidance of the test engineer

3.2 Acronyms

AVO	Avoid Verbal Orders
COB	Close of Business
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COTR	Contracting Officer's Technical Representative
DID	Discharge Ionization Detector
FID	Flame Ionization Detector
GC/MS	Gas Chromatograph/Mass Spectrometer
GOX	Gaseous Oxygen
LH_2	Liquid Hydrogen
LN_2	Liquid Nitrogen
LOX	Liquid Oxygen
MSDS	Material Safety Data Sheet
MSFC	Marshall Space Flight Center
MTI GC	Microsensor Technology, Inc., Gas Chromatograph
NASA	National Aeronautics and Space Administration
Nitrox	Gaseous Nitrogen/Oxygen mixture
NVR	Non-Volatile Residue
OWI	Organizational Work Instruction
POC	Point of Contact
PPE	Personal Protective Equipment
ppm	parts per million
RGA	Reduction Gas Analyzer
RGD	Reduction Gas Detector
TCD	Thermal Conductivity Detector
THC	Total Hydrocarbons

4.0 Instructions

Warning
DO NOT PERFORM LEAK CHECKS ON CRYOGEN SAMPLING POINTS. Leak checks of cryogen sampling points are outside the scope of work of the Environmental Gas Laboratory.

Note: Environmental Gas Laboratory sampling shall be limited to points that have a maximum pressure of 5, 000 psi. All gas and cryogenic liquid sampling fittings used in Environmental Gas Laboratory sampling are rated for at least 5,000 psi.

Note: *If sampling equipment is determined to be defective,* **remove** the equipment from use immediately, and **replace** the hardware with rated equipment.

CAUTION: Cryogen sampling shall be always performed at 20 psi or less. Regulating devices are never used when sampling cryogens.

CAUTION: Cryogen sampling shall be only conducted in the presence of the Point of Contact (POC) for a sampling point.

4.1 Sample Collection

4.1.1. Specific procedures for sampling individual gases and cryogenic liquids shall be determined by several factors, including:

- Whether sample is gaseous or cryogenic
- The nature of the specific gas or cryogen
- Whether sample is to be drawn under low or high pressure
- Whether sample is to be drawn inside or outside an MSFC test area.

4.1.2. Each procedure also involves different requirements for:

- The sampling equipment to use
- The Personal Protective Equipment (PPE) to wear
- The volume of sample to collect
- The safety precautions to observe.

Note: All operations involving the sampling of liquid hydrogen, gaseous hydrogen, liquid oxygen, or gaseous oxygen shall be performed by two or more technicians.

CAUTION: When performing all sampling, personnel shall **stand to the side** of the sampling port.

4.1.3. Sampling requirements for each gas and cryogen are found in the documents listed below:

- Air (missile grade)/Breathing Air: MSFC-PROC-404, ASTM F 307, ANSI CGA G-7.1

- Nitrogen: MSFC-PROC-404, ASTM F 307, MIL-PRF-27401D, (liquid) ASTM F 310

- Oxygen: MSFC-PROC-404, ASTM F 307, MIL-PRF-25508F, (liquid) ASTM F 310

  Note: Oxygen systems shall always be grounded. Personnel shall always **connect** to the sampling point before allowing gas to flow, shall **use** brass (non-sparking) tools, and shall **wear** an anti-static suit while performing field testing. By following this procedure, both equipment and oxygen points are grounded.

- Hydrogen: MSFC-PROC-404, ASTM F 307, MIL-PRF-27201C, (liquid) ASTM F 310

  Note: Hydrogen systems shall be grounded. Personnel shall always **connect** to the sampling point before allowing gas to flow, shall **use** brass (non-sparking) tools, and shall **wear** an anti-static suit while performing field testing. By following this procedure, both equipment and hydrogen points are grounded.

- Argon: MSFC-PROC-404, ASTM F 307, MIL-PRF-27415A, (liquid) ASTM F 310

- Helium: MSFC-PROC-404, ASTM F 307, MIL-PRF-27407B, (liquid) ASTM F 310

4.1.4. Preparing to Conduct Sampling

EGL personnel **shall perform** the following procedures:

- Each morning, **review** the weekly schedule to determine the sample points to be conducted that day.
- **Collect** the appropriate sampling and personal protective equipment (see section 6.0) from Room 126 in Building 4623. (See Table 4.1 for a list of equipment for particular samples.)
- **Visually inspect** all equipment for proper working condition.
- **Ensure** that equipment inspections and calibrations are current.
- **Secure** the sampling equipment and PPE in the vehicle to ensure the equipment is not damaged and not a hazard to the driver.

4.1.5. Procedures for sample points **with** reducing regulators: For N_2, O_2, and Air, **connect** the sample filter housing to the sample port. **Connect** the digital flow meter to the outlet of the filter housing. **Initiate** the gas flow by turning the pressure regulator until a flow of 125 L/min is observed on the flow meter readout. The sample port regulated pressure gauge shall read between 22.5 psig and 25

Table 4.1.
Sampling Equipment and PPE

Sample to be Drawn	Sampling Equipment	Personal Protective Equipment
Liquid nitrogen	Cosmodyne# 1154 Cosmodyne# 1397	Safety glasses Face shield Cryo-proof gloves Hard hat, if required Ear plugs (optional)
Liquid oxygen	Cosmodyne# 1158	Brass (non-sparking) tools Safety glasses Face shield Cryo-proof gloves Non-static jumpsuit Hard hat, if required Ear plugs (optional)
Gaseous oxygen	Whitey # W1G9111 (1 liter) Whitey # W1G9202 (1 liter) Whitey # W1G9200 (1 liter) Leak-check solution	Brass (non-sparking) tools Safety glasses Cotton gloves Non-static jumpsuit Hard hat, if required Ear plugs (optional)
Routine air and gaseous nitrogen	Swagelok cylinders (24) (500 ml) Leak-check solution	Safety glasses Ear plugs Hard hat, if required Ear plugs (optional)
Gaseous hydrogen (shall be used for other low-pressure gases when a high sample volume is needed)	Watermelon sample cylinders (A, B, and C) (~45 liters each) Leak-check solution	Brass (non-sparking) tools Safety glasses Cotton gloves Non-static jumpsuit Hard hat, if required

psig. **Flow** at this rate for 3 minutes. This provides total gas volume through the filter housing in excess of the specified minimum of 30 scf.

4.1.6. Procedures for sample points **without** reducing regulators: For N_2, O_2, and Air, **connect** the sample filter housing to the sample port. **Connect** the digital flow meter to the outlet of the filter housing. **Initiate** the gas flow by opening the sample port isolation valve until a flow of 125 L/min is observed on the flow meter readout. The sample port regulated pressure gauge shall read between 22.5 psig and 25 psig. **Flow** at this rate for 3 minutes. This provides total gas volume through the filter housing in excess of the specified minimum of 30 scf.

CAUTION: When testing high-pressure Air >3000 psi, the point shall be treated as GOX.

4.2 Procedure for Sampling Low-Pressure Points

Note: Collection procedures for low-pressure samples usually do not require use of a regulator; however, when the main supply valve to a low-pressure sampling

point is not within arm's reach of the sampling point (so that the main supply valve can be closed immediately in event of a leak), a portable regulating device is required.

EGL personnel **shall perform** the following procedures:

4.2.1. *If the low-pressure point to be sampled is in a test area,* **follow** these security procedures:

- At the test area entrance, **determine** if warning lights are on or if barriers are present. *If either warning lights are on or barriers are in effect*, **do not attempt to enter the area. Revisit** the area another day when warning lights are not on and barriers are not present.
- At the test area entrance, *if warning lights are not on and barriers are not present,* **contact** the site's Point of Contact to **determine** the system's status and to **confirm** that no testing shall be initiated during sampling. *If the test area has a sign-in procedure*, **record** your entry.
- After sampling in a test area is complete, **notify** the POC of your departure from the area, and *if the test area has a sign-in procedure,* **record** your exit.

Note: Only persons who have completed MSFC Test Area Training and who are specifically badged for access to test areas shall enter the MSFC test areas.

4.2.2. After arriving at the sampling site, **check** if the sampling point is in use. *If any equipment is attached to the sampling point,* **do not sample** the point. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why.

4.2.3. **Don** appropriate PPE. (**See** Table 4.1).

4.2.4. *If the sampling point is not in use,* **check** the point for visual, audible, or tactile signs of leaks.

4.2.5. *If a leak is suspected,* **perform** one of the following two options:

Warning
DO NOT PERFORM LEAK CHECKS ON CRYOGEN SAMPLING POINTS. Leak checks of cryogen sampling points are outside the scope of work of the Environmental Gas Laboratory.

4.2.5.1. Option 1: **Check** for leakage with a leak-detection solution. (Leak detection solutions for oxygen and hydrogen systems shall be Type II MIL-L-25567 and shall be certified for oxygen and/or hydrogen systems.) **Spray** the solution on the area suspected of leaking and **look** for bubbling, which indicates leakage.

- *If the leaking area is identified,* **notify** the POC of the leak**.** On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access" and **indicate** the reason why. **Do not sample** the point until the leak has been repaired.
- *If the leaking cannot be identified but is still suspected,* **do not sample** the point. **Notify** the POC of the leak**.** On the Gases and Liquids Report

Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access" and **indicate** the reason why.

- *If the sample point is determined to be free of leaks,* **continue** the sampling procedure with step 4.2.6.

4.2.5.2. Option 2: **Do not perform** a leak check *if there are safety concerns about performing the procedure.* **Do not sample** the point. **Notify** the POC of the suspected leak and the associated hazards**.** On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access" and **indicate** the reason why.

4.2.6. *If the sampling point is tagged out, d***o not sample** the point. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why.

4.2.7. *If the sampling point is not in use, is not leaking, and is not tagged out,* **check** the system's pressure gauge to confirm that the system pressure is not above the safe limits of the sampling equipment being used.

4.2.8. **Check** the calibration date of the system gauge. *If the calibration has expired or if there is no calibration sticker on the gauge*, **do not attempt to sample** the point. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why. **Notify** the POC.

4.2.9. **Ensure** that the supply valve to the sample point is closed.

CAUTION: When performing this step, **stand to the side** of the sample port.

Note: *If the system sample port has no cap,* **proceed** to step 4.2.12.

4.2.10. **Turn** the cap covering the sample port just enough to allow any gas remaining in that section to bleed off.

4.2.11. After remaining gas is bled off, totally **remove** the cap covering the sample port.

4.2.12. **Inspect** the system sampling port for visible contamination.

- *If the port is contaminated*, **do not sample** the port. **Notify** the POC. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why. **Do not attempt** to sample the point until it has been decontaminated.
- *If the port is not contaminated,* **proceed** to step 4.2.13

4.2.13. The type of gas to be sampled and the pressure of the particular system determine the sampling equipment to be used. [Hard tube fittings are usually used (1) for low-pressure gas sampling; (2) for air/GN_2 at pressures less than 5,000 psi with a portable hand regulator; (3) with portable hand regulators that are GOX specific for GOX in systems with equal to or less than 3000 psi, on /GN_2 at pressures equal to or less than 5,000 psi, and for GH_2/GHe equal to or less than 5,000 psi; or (4) when portable regulator boxes are used as backups to the hand-held regulators. Flex hoses are not required.]

CAUTION: When testing high-pressure Air >3000 psi, the point shall be treated as GOX.

Note: The hand-held regulators are also used on systems with equal to or less than 5,000 psi when they can be placed close enough to the sample ports for the hard tube fittings to make a secure connections.

4.2.14. **Secure** the connecting fitting or hose finger tight to the sample port. After the connection is finger tight, **use** a brass wrench to tighten it another 1/4 to 1/2 turn.

4.2.15. **Open** both the inlet and outlet valves on the sampling cylinder.

4.2.16. **Slightly open** the main supply valve (or regulator, in special situations) to the sampling port.

Note: The main supply valve does not have to be opened fully, since a minimum amount of low-pressure gas is required to sample the point.

CAUTION*: If a hissing sound occurs when the main supply valve is opened,*
(a) The connection from the sampling device to the sample port may not be snug. **Close** the main supply valve immediately, and **reconnect** the sampling device to the sample port. **Open** the main supply valve slightly, and **listen** for hissing sounds. *If none are present*, **continue** with the sampling procedure.
(b) The pre-sampling leak check may not have revealed leaks present in the system. These undetected leaks may become obvious after the main supply valve has been opened. When such an undetected leak is discovered, **immediately close** the main supply valve, **disconnect** the sampling device from the sample port, and **cap** the port. **Notify** the POC. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why.

4.2.17. *If no leaking is evident,* **allow** the system gas to purge the sampler cylinder for 1 to 2 minutes. (**Refer** to steps 4.1.5 and 4.16.)

4.2.18. **Close** the outlet valve of the cylinder.

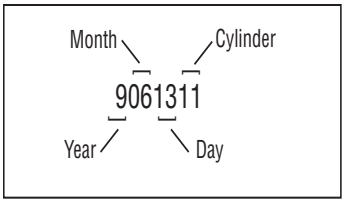
4.2.19. **Collect** the sample to fulfill the requirements of MSFC-PROC-404 and the routine orders or AVO.

4.2.20. After collecting the sample, **close** the inlet valve on the sample cylinder and then **close** the main supply valve.

4.2.21. Gently **loosen** the attachment fitting to allow pressure to return to ambient.

4.2.22. **Replace** the sample port cap, and **securely tighten** it.

4.2.23. **Log** samples using the *Daily Sample Log Sheet.* (**See** Figure 7.3-1 for example of log sheet). Samples are tracked by a log number, which shall be determined in the following manner and written in the following format:



Year/month/day of month/cylinder #
Example: 9061311

Note: When the same cylinder is used more than once in a day, the log number shall be appended at the end with a letter corresponding to the number of times the cylinder was used.

4.2.24. **Return** all samples to the Environmental Gas Laboratory in Building 4623 for analysis.

4.3 Procedure for Sampling High-Pressure Points

EGL personnel **shall perform** the following procedures:

4.3.1. *If the high-pressure point to be sampled is in a test area,* **follow** these security procedures:

- At the test area entrance, **determine** if warning lights are on or if barriers are present. *If either warning lights are on or barriers are in effect*, **do not attempt to enter the area. Revisit** the area another day when warning lights are not on and barriers are not present.
- At the test area entrance, *if warning lights are not on and barriers are not present,* **contact** the site's POC to **determine** the system's status and to **confirm** that no testing shall be initiated during sampling. *If the test area has a sign-in procedure*, **record** your entry.

- After sampling in a test area is complete, **notify** the POC of your departure from the area, and *if the test area has a sign-in procedure,* **record** your exit.

Note: Only persons who have completed MSFC Test Area Training and who are specifically badged for access to a test area shall enter the MSFC test areas.

4.3.2. After arriving at the sampling point, **check** if the sampling point is in use. *If any equipment is attached to the sampling port,* **do not sample** the port. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why.

4.3.3. **Don** appropriate PPE. (**See** Table 4.1).

4.3.4. *If the sampling point is not in use,* **check** the point for visual, audible, or tactile signs of leaks.

Warning
DO NOT PERFORM LEAK CHECKS ON CRYOGEN SAMPLING POINTS. Leak checks of cryogen sampling points are outside the scope of work of the Environmental Gas Laboratory.

4.3.5. *If a leak is suspected,* **perform** one of the following two options:

4.3.5.1. Option 1: **Check** for leakage with a leak-detection solution. **Spray** the solution on the area suspected of leaking, and **look** for bubbling, which indicates leakage.

- *If the leaking area is identified,* ***notify*** the POC of the leak**.** On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why. **Do not sample** the point until the leak has been repaired.
- *If the leaking cannot be identified but is still suspected,* **do not sample** the point. **Notify** the POC of the leak**.** On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why.
- *If the sample point is determined to be free of leaks,* **continue** the sampling procedure with step 4.3.6.

4.3.5.2. Option 2: **Do not perform** a leak check, *if there are safety concerns about performing the procedure.* **Do not sample** the point. **Notify** the POC of the suspected leak and associated hazards**.** On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access;" **indicate** the reason why.

4.3.6. *If the sampling point is tagged out,* **do not sample** the point. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access;" **indicate** the reason why.

4.3.7. *If the sampling point is not in use, is not leaking, and is not tagged out,* **check** the system's pressure gauge to confirm that the system pressure is not above the safe limits of the sampling equipment.

4.3.8. **Check** the calibration date of the system gauge. *If the calibration has expired or if there is no calibration sticker on the gauge*, **do not attempt to sample** the point. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why. **Notify** the POC.

4.3.9. **Ensure** that the supply valve to the sample port is closed.

CAUTION: When performing this step, **stand to the side** of the sample port.

Note: *If the system sample port has no cap,* **proceed** to step 4.3.12.

4.3.10. **Turn** the cap covering the sample port just enough to allow any gas remaining in that section to bleed off.

4.3.11. After remaining gas is bled off, totally **remove** the cap covering the sample port.

4.3.12. **Inspect** the sampling port for visible contamination.

- *If the port is contaminated*, **do not sample** the port. **Notify** the POC. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access," and **indicate** the reason why. **Do not attempt** to sample the point until it has been decontaminated.
- *If the port is not contaminated,* **proceed** to step 4.3.13 to make connection to the sampling port.

4.3.13. The type of gas to be sampled and the pressure of the particular system determine the sampling equipment to be used. [Hard tube fittings are usually used (1) for low-pressure gas sampling; (2) for air/GN_2 at pressures less than 2,500 psi with a portable hand regulator; (3) with the portable regulator boxes on GOX at pressures equal to or less than 3,000 psi, on GN_2 at pressures equal to or less than 5,000 psi, and GH_2/GHe equal to or less than 5,000 psi; or (4) when the portable regulator boxes can be placed close enough to the sample port for the hard tube fitting to make a secure connection. Flex hoses are used when a hard tube fitting cannot reach a sample port from a portable regulator box.]

CAUTION: When testing high-pressure Air >3000 psi, the point shall be treated as GOX.

CAUTION: *If a flex hose is used,* **anchor** the flex hose to the sample port area and also to the inlet area of the regulating device.

4.3.14. **Secure** the connecting fitting or hose finger tight to the sample port. After the connection is finger tight, **use** a brass wrench to tighten it another 1/4 to 1/2 turn.

4.3.15. **Close** the portable hand regulator or regulator box.

4.3.16. **Remove** the cap from the Outlet Sample Port on the regulator box.

4.3.17. **Slightly open** the main supply valve to the sampling port.

Note: The main supply valve does not have to be opened fully, since a minimum amount of low-pressure gas is required to sample the point.

CAUTION: *If the regulating device is malfunctioning, e.g., if the Outlet Sample Port is emitting gas or the regulator box is leaking*, **close** the main supply valve, **bleed off** the pressure to ambient, and **remove** the regulating device from use. **Do not reuse** the device until it has been serviced and tested by the Valve Lab.

CAUTION: The pre-sampling leak check may not always reveal leaks present in the system. Undetected leaks may become obvious after the main supply valve has been opened. When such a leak is discovered, **immediately close** the main supply valve; **bleed off** the gas pressure through the regulator, **close** the regulator, **disconnect** the sampling device from the sample port; and **cap** the port. **Notify** the POC. On the Gases and Liquids Report Routine Orders (Figure 7.3-3), **record** the status of the point as having "No Access;" **indicate** the reason why.

4.3.18. **Open** and **purge** the regulator by flowing sample gas from the sample port through the device for 1-2 minutes. **Purge** at approximately 20 psi or at no greater than 50 psi.

4.3.19. **Close** the regulator.

4.3.20. Loosely **attach** a hard tube fitting to the regulator Outlet Sample Port. Loosely **attach** the sampler cylinder to the free end of the hard tube. **Stabilize** the sampling cylinder securely, resting the end of the cylinder on the ground or another support. **Finger tighten** the fitting between the cylinder and the hard tube; then **secure** the connection using a brass wrench to give an additional 1/4 to 1/2 turn. Finger tighten the hard tube to the Outlet Sample Port; **secure** the connection using a brass wrench to give an additional 1/4 to 1/2 turn.

4.3.21. **Open** both the inlet and outlet valves on the cylinder.

4.3.22. **Slightly open** the regulator**,** and **purge** the cylinder by flowing sample gas from the sample port through the regulator and cylinder for 1-2 minutes. (**Refer** to steps 4.1.5 and 4.16.)

4.3.23. **Close** the outlet valve on the cylinder, and **wait** for the outlet pressure gauge to stabilize.

CAUTION: When performing all sampling, **stand to the side** of the sampling port.

4.3.24. **Collect** the sample, regulating the gas levels to fulfill the requirements of MSFC-PROC-404 and the routine orders or AVO.

4.3.25. After collecting the sample, **close** the cylinder intake valve and the regulator.

4.3.26. **Close** the main supply valve.

4.3.27. **Slightly loosen** the connection between the hard tube fitting and the sample cylinder to bleed the pressure. When the pressure in the fitting has reached ambient, completely **disconnect** the cylinder.

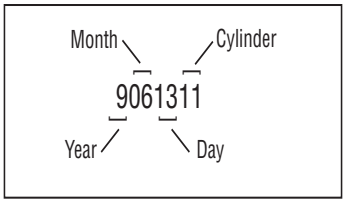
4.3.28. **Slightly loosen** the connection between the hard tube fitting and the Outlet Sample Port on the regulator to bleed the pressure. When the pressure between the regulator and the fitting has reached ambient, **disconnect** the hard tube fitting.

4.3.29. **Open** the regulator to bleed the gas between the supply and the regulator. When ambient pressure is reached, **disconnect** the hard tube fitting or flex hose and regulator from the sample port.

4.3.30. **Replace** the regulator Outlet Sample Port cap, and securely **tighten** it.

4.3.31. **Replace** the sample port cap, and **securely tighten** it.

4.3.32. **Log** samples using the *Daily Sample Log Sheet.* (**See** Figure 7.3-1 for example of log sheet). Samples are tracked by a log number, which shall be determined in the following manner and written in the following format:
Year/month/day of month/cylinder #
Example: 9061311



Note: When the same cylinder is used more than once in a day, the log number shall be appended at the end with a letter corresponding to the number of times the cylinder was used.

4.3.33. **Return** all samples to the Environmental Gas Laboratory in Building 4623 for analysis.

4.4 Special Sampling Procedures

Liquid oxygen and liquid hydrogen have special pre-sampling, sampling, and safety requirements related to the nature of the gas and the analyses required by MSFC. EGL personnel **shall follow** the procedures listed below:

4.4.1. Procedure for Sampling Liquid Oxygen

Note: Equipment used in the sampling of liquid oxygen shall be rated for liquid oxygen. **Verify and use** this equipment only for sampling liquid oxygen.

CAUTION: When connecting and disconnecting liquid oxygen sampling equipment, **use only brass tools.**

4.4.1.1. **Purg**e the sample cylinder to be used with nitrogen; **fill** the cylinder with nitrogen; and **analyze** the nitrogen to check the cylinder for contamination.

4.4.1.2. LOX samples are generally taken inside secured test areas. When arriving at the test area, **personally notify** the POC of the intent to conduct sampling. **Ensure** that the test conductor overseeing the test area is aware of the intent to conduct sampling.

CAUTION: When the test conductor has approved sampling, **ensure** that persons in the area have been notified that a propellant transfer is imminent. *If no warnings are issued,* **do not sample** the site.

4.4.1.3. Before entering the sampling area**, remove any electronic devices**, *e.g.,* cell phones, pagers, watches. **Leave** these in the vehicle.

Note: For the following steps, **wear** non-static jumpsuits, cryo-proof gloves, ear plugs, splash shields, and hard hats. The technician has authority to remove earplugs when necessary to hear the flow of gas.

4.4.1.4. When arriving at the sample point, **scan** the area for contaminants, especially for items that contain hydrocarbons, such as tar, oil, or paint. Also inspect the soles of footwear for contaminants.

Note: *If hydrocarbon contamination is suspected*, **notify** the POC and the test conductor immediately. **Evacuate** the area; **do not attempt to collect** a sample. **Return** to collect the sample only after the area has been decontaminated.

4.4.1.5. *If the area is clean*, **notify** the POC of the system pressure needed for sampling. (A pressure of <40 psi is ideal.)

4.4.1.6. While the POC is pressurizing the system, **set up** the sampling equipment.

4.4.1.7. **Conduct** the sampling according to the procedures outlined in section 4.1.2 (low-pressure points).

4.4.1.8. When sampling is completed, **remove** non-static jumpsuit.

CAUTION: Do not enter a vehicle for a minimum of 20 minutes.

CAUTION: Do not smoke or expose clothing to an open flame 30 minutes after sampling LOX.

4.4.1.9. **Notify** the test conductor that sampling is finished.

4.4.2. Procedure for Sampling Liquid Hydrogen

The sampling of liquid hydrogen is a very specialized and dangerous operation. Individual sampling plans shall be developed for each liquid hydrogen sampling request.

4.5 Procedures for Particulate and Moisture Sampling

EGL personnel **shall follow** the procedures listed below:

4.5.1. Procedure for Sampling Moisture

4.5.1.1. **Prepare** the moisture meter by removing the clamp that attaches the tubing to the outer cover of the meter. **Unzip** the flap to expose the digital readout and power button. **Turn on** the meter power.

4.5.1.2. **Remove** the cap from the meter tube fitting and **hand tighten** the meter to the sample point.

4.5.1.3. **Slowly open** the sample point supply valve until gas flows from the vent port of the moisture meter.

4.5.1.4. **Cover** the meter vent port with a finger, and **allow** the desiccant canister on top of the moisture meter to fully extend.

4.5.1.5. After the digital readout on the meter has stabilized (about 10 seconds), **record** the moisture reading, and **enter** the reading on the Daily Sample Log Sheet (Figure 7.3-1).

4.5.1.6. **Push** the desiccant canister completely down; then **shut off** the gas flow.

4.5.1.7. **Remove** the meter tube from sample point, and **cap** the end of the tube fitting.

4.5.1.8. **Turn off** the moisture meter, and **clamp** the hose to the outer cover of the meter.

4.5.2. Procedure for Sampling Particulates

Note: *If the gas sample for the point has already been taken, the 2-minute purge conducted, and sample fittings have already been attached*, **proceed** at step 4.5.2.3.

4.5.2.1. **Purge** the sample port at a rate of 10 (± 1) scfm for 2 minutes. **Purge** systems that do not have a 10.0-scfm-flow capability at their maximum flow rate until a total volume of 20 scfm is achieved.

4.5.2.2. **Use** the necessary fittings to attach the inlet port of the filter housing to the sample point.

4.5.2.3. **Slowly open** the sample point main supply valve (or regulator, in special situations) until a positive flow (~0.5 scfm) is felt from the gas sampling tubing.

4.5.2.4. **Place** the filter housing inlet in the gas flow path, **remove** the inlet cap, and **finger tighten** the filter housing to the tubing.

4.5.2.5. **Stop** the gas flow.

4.5.2.6. **Attach** a flow meter capable of measuring 15.0 scfm downstream of the filter housing.

4.5.2.7. **Increase** the sample port flow rate to 10 scfm, and **allow** the flow to continue for 3 minutes (until 30 scfm of gas passes through the filter housing). For systems not capable of a flow rate of 10 scfm, **allow** the gas to flow until 30 scfm has passed through the filter housing.

4.5.2.8. After 30 scfm has been filtered, **reduce** the flow rate to ~0.5 scfm, and **disconnect** the flow meter.

4.5.2.9. **Disconnect** the filter housing. While maintaining its position in the 0.5 scfm gas flow path, **cap** the filter housing inlet.

4.5.2.10. **Turn off** the gas flow, and **remove** remaining sampling hardware.

4.5.2.11. **Install** the sample point protective cap.

4.5.2.12. **Ensure** that the filter housing remains in an upright position while returning it to the Environmental Gas Laboratory for analysis.

4.6 Sample Logging

4.6.1. The daily folder shall contain the *Daily Sample Log Sheet,* all chromatograms, calibration data, calculations, and any other raw data required for that day's analysis. The daily folder shall be kept in the Toxicity Laboratory.

4.6.2. The same log sheet serves as a daily report of analytical results and is used for generating the weekly report.

4.7 Test Procedures for Gas Analysis

Note: Moisture. For determination of the moisture content of gas samples, personnel **shall follow** the directions detailed in the *Shaw "Award" Dewpoint Meter Instruction Manual Models SADP-S & ADP-Z.*

EGL personnel **shall follow** the procedures listed below. A summary of the applicable Line Items appears in Table 7.1-2.

4.7.1. Room Air Analysis (Line Item 4): **Follow** the instructions in MSFC-PROC-404 for analysis of room air. The analyses performed are listed in Table 4.7-1.

Table 4.7-1.
Room Air Analyses

Analysis	Room Air	Analysis	Room Air
Moisture	24 ppm max	Particles 30-100	25 max
Total hydrocarbons	5 ppm max	Particles >100	0 max

4.7.2. Gaseous Nitrogen (Line Item 5): **Follow** the instructions in MSFC-PROC-404 for analysis of gaseous nitrogen. The analyses performed are listed in Table 4.7-2.

Table 4.7-2.
GN_2 Analyses

Analysis	GN_2	Analysis	GN_2
Moisture	24 ppm max	Particles 30-100	25 max
Total hydrocarbons	5 ppm max	Particles >100	0 max

4.7.3. Gaseous Helium (Line Item 6): **Follow** MSFC-PROC-404 instructions for analysis of gaseous helium. The analyses performed are listed in Table 4.7-3.

4.7.4. Gaseous Argon (Line Item 7): **Follow** instructions in MSFC-PROC-404 for analysis of gaseous argon. The analyses performed are listed in Table 4.7-4.

Analysis	GHe	Analysis	GHe
Moisture	24 ppm max	Particles 30-100	25 max
Total hydrocarbons	5 ppm max	Particles >100	0 max

Table 4.7-3.
Gaseous Helium Analyses

Analysis	Gaseous Argon	Analysis	Gaseous Argon
Moisture	24 ppm max	Particles 30-100	25 max
Total hydrocarbons	5 ppm max	Particles >100	0 max

Table 4.7-4.
Gaseous Argon Analyses

4.7.5. Gaseous Hydrogen (Line Item 8): **Follow** instructions in MSFC-PROC-404 and MIL-P-27201 for analysis of gaseous hydrogen. The analyses performed are listed in Table 4.7-5.

Analysis	Gaseous Hydrogen	Analysis	Gaseous Hydrogen
Nitrogen + Moisture + Volatile Hydrocarbons	9 ppm max	Particles 30-100	25 max
Oxygen + Argon	1 ppm max	Particles >100	0 max

Table 4.7-5.
Gaseous Hydrogen Analyses

4.7.6. Liquid Hydrogen (Line Item 9): **Follow** the instructions in MIL-P-27201 for analysis of liquid hydrogen. The analyses performed are listed in Table 4.7-6.

Analysis	Liquid Hydrogen	Analysis	Liquid Hydrogen
Nitrogen + Moisture + Volatile Hydrocarbons	9 ppm max	Particulates	1 mg/*l* max
Oxygen + Argon	1 ppm max		

Table 4.7-6.
Liquid Hydrogen Analyses

4.7.7. Gaseous Nitrogen (Line Item 10): **Follow** the instructions in MSFC-PROC-404 and MIL-P-27201 for analysis of gaseous nitrogen. The analyses performed are listed in Table 4.7-7.

Analysis	Gaseous Nitrogen	Analysis	Gaseous Nitrogen
Oxygen	50 ppm max	Particles 30-100	25 max
Moisture	11.5 ppm max	Particles >100	0 max
Total Hydrocarbons	5.0 ppm max		

Table 4.7-7.
Gaseous Nitrogen Analyses

4.7.8. Liquid Nitrogen (Line Item 11): **Follow** the instructions in MIL-P-27201 for analysis of liquid nitrogen. The analyses performed are listed in Table 4.7-8.

Table 4.7-8.
Liquid Nitrogen Analyses

Analysis	Liquid Nitrogen	Analysis	Liquid Nitrogen
Oxygen	50 ppm max	Total Hydrocarbons	5.0 ppm max
Moisture	11.5 ppm max	Particulates	1 mg/*l*

4.7.9. Gaseous Oxygen (Line Item 12): **Follow** the instructions in MSFC-PROC-404 and MIL-P-25508 for analysis of gaseous oxygen. The analyses performed are listed in Table 4.7-9.

Table 4.7-9.
Gaseous Oxygen Analyses

Analysis	Gaseous Oxygen	Analysis	Gaseous Oxygen
Purity	99.99% units min	Other (nitrogen, argon, krypton, etc.)	75 ppm max
Moisture	3 ppm max		
Total Hydrocarbons	50 ppm max	Odor	None
Acetylene	.05 ppm max	Particles 30-100	25 max
Methane	16 ppm max		
CO_2/CO	1 ppm max	Particles >100	0 max

4.7.10. Liquid Oxygen (Line Item 13): **Follow** the instructions in MIL-P-25508 for analysis of liquid oxygen. The analyses performed are listed in Table 4.7-10.

Table 4.7-10.
Liquid Oxygen Analyses

Analysis	Liquid Oxygen	Analysis	Liquid Oxygen
Purity	99.6% units min	Acetylene	0.25 ppm max
Moisture	3 ppm max	Particulates	1 mg/*l* max
Total Hydrocarbons	50 ppm max		

4.7.11. Gaseous Helium (Line Item 14): **Follow** the instructions in MSFC-PROC-404 and MIL-P-27401 for analysis of gaseous helium. The analysis performed are listed in Table 4.7-11.

Table 4.7-11.
Gaseous Helium Analyses

Analysis	Gaseous Helium	Analysis	Gaseous Helium
Total Impurities	50 ppm max	Nitrogen + Argon	14 ppm min
Moisture	9 ppm max	Carbon dioxide	1 ppm max
Total Methane	5 ppm max	Carbon monoxide	1 ppm max
Oxygen	3 ppm max	Particles 30-100	25 max
Neon	23 ppm max	Particles >100	0 max
Hydrogen	1 ppm max		

4.7.12. Breathing Air (Line Item 15): For analysis of breathing air, **follow** the instructions in MSFC-PROC-404 and ANSI CGA G-7.1. The analyses performed are listed in Table 4.7-12.

Analysis	Breathing Air	Analysis	Breathing Air
Oxygen	19.5-23.5% max	Odor	None
Moisture	24 ppm max	Mass spectral scan	No excessive contamination
Total hydrocarbons	5 ppm max	Particles 30-100	1 ppm max
Carbon monoxide	10 ppm max	Particles >100	25 max
Carbon dioxide	500 ppm max		

Table 4.7-12.
Breathing Air Analyses.

4.7.13. Ultra High Purity Argon Grade 5.0 (Line Item 19): **Follow** the specifications for grade 5.0 argon for analysis of gaseous argon. The analyses performed are listed in Table 4.7-13.

Analysis	Ultra High Purity Argon Grade 5.0	Analysis	Ultra High Purity Argon Grade 5.0
Purity	99.999% max	Hydrogen	3 ppm max
Total Hydrocarbons	0.5 ppm max	Water	1 ppm max
Nitrogen	5 ppm max	Oxygen	1 ppm max

Table 4.7-13.
Ultra High Purity Argon Analyses.

4.7.14. Ultra High Purity Helium Grade 5.0 (Line Item 20): **Follow** the specifications for grade 5.0 ultra high purity helium for analysis of gaseous helium. The analyses performed are listed in Table 4.7-14.

Analysis	Ultra High Purity Helium Grade 5.0	Analysis	Ultra High Purity Helium Grade 5.0
Purity	99.999% max	Oxygen	1 ppm max
Total Hydrocarbons	0.5 ppm max	Carbon monoxide	5 ppm max
Water	1 ppm max	Carbon dioxide	3 ppm max

Table 4.7-14.
Ultra High Purity Helium Analyses

4.7.15. Gaseous Nitrox (Line Item 23): **Follow** the instructions in MSFC-PROC-404 for analysis of nitrox. The analyses performed are listed in Table 4.7-15.

Analysis	Nitrox	Analysis	Nitrox
Moisture	24 ppm max	Particles 30-100	25 max
Total Hydrocarbons	5 ppm max	Particles >100	0 max

Table 4.7-15.
Gaseous Nitrox Analyses

4.8 NVR Procedures and Analysis

EGL personnel **shall follow** the procedures listed below:

4.8.1. **Prepare** to conduct sampling.

- The solvent to be used shall be prefiltered and distilled.
- Clean glassware shall be used at all times
- All preparation of sample bottles and filtering apparatus shall be performed under a laminar flow bench
- All distillation of samples shall be performed under a vacuum hood
- Sample bottles shall have Teflon® tops
- A clean, Teflon® rinse bottle containing the filtered and distilled solvent shall be used.

4.8.2. **Collect** and **filtrate** the verification sample.

4.8.2.1. Using the rinse bottle containing the filtered, distilled solvent, **rinse** the funnel, sample bottle, and top to be used in the collection of the verification sample under the flow bench.

4.8.2.2. **Capture** all of the solvent flushed through the test article in the sample bottle(s).

4.8.2.3. Using the filtered, distilled solvent, **rinse** the inside of the funnel into the sample bottle.

4.8.2.4. Using the filtered, distilled solvent, **rinse** the top for the sample bottle again, and immediately plug the sample bottle with the top.

4.8.2.5. **Place** the sample bottle under the laminar flow bench.

4.8.2.6. Using the filtered, distilled solvent, **rinse** on both sides the filter pad to be used, and **load** it onto the filtering frit.

4.8.2.7. Using the filtered, distilled solvent, **rinse** the filtering cup, and **clamp** it over the filter pad.

4.8.2.8. Using the filtered, distilled solvent, **rinse** a watch glass, and **cover** the filtering cup.

4.8.2.9. Using the filtered and distilled solvent, **rinse** the outside of the sample bottle and top.

4.8.2.10. **Lift** the watch glass, and **decant** 250 ml of the sample into the filtering cup.

4.8.2.11. Using the filtered, distilled solvent, **rinse** the underside of the watch

glass, place it over the filtering cup. Using the filtered, distilled solvent, **rinse** the top for the sample bottle, and **return** it to the sample bottle.

4.8.2.12. **Filter** the first 250 ml of the sample through the filter pad at a vacuum of 24 in. of mercury.

4.8.2.13. After the first 250 ml have been filtered, **decant** the remaining sample into the filter cup. Using the filtered, distilled solvent, **rinse** the inside of the sample bottle three times, **add** the rinses to the filter cup, and **rinse** the watch glass, and **place** it over the filter cup.

4.8.2.14. When the entire sample has been filtered, **lift** the watch glass. Using the filtered, distilled solvent, **rinse** the inside of the filter cup three times, and **filter** the rinse.

4.8.2.15. **Unclamp** the filter cup, and **transfer** the filter pad to a clean filter pad slide. Using the filtered, distilled solvent, **rinse** the lid for the filter pad slide. **Place** the rinse lid over the filter pad slide containing the filter pad.

4.8.3. **Distill** and **analyze** the NVR

Note: Do not use a vacuum pump with the distilling unit.

4.8.3.1. **Use** a clean distillation flask and a clean distillate flask.

4.8.3.2. **Place** the filtration flask containing the filtered sample under the vacuum hood where the distilling unit is located.

4.8.3.3. **Transfer** the filtered sample to the distillation flask. Using the filtered, distilled solvent, **rinse** the inside of the filter flask three times, and **add** the rinse to the distillation flask.

4.8.3.4. **Set** the temperature of the distilling unit at the boiling point of the solvent, and **increase** the temperature 1 degree every 15 minutes until the vapors from the distillation flask start condensing into the distillate flask. When the vapors begin to condense, the distillation point of the solvent for this distilling unit has been reached. **Do not raise** the temperature beyond the distillation point.

Note: Distillation of a 500-ml sample at the distillation point takes approximately 1 hour.

4.8.3.5. **Observe** the rotating distillation flask. When all of the sample has condensed into the distillate flask, **stop** the rotating distillation flask, and **raise** it from the hot bath.

4.8.3.6. **Allow** the distillation flask to sit for 5 minutes.

4.8.3.7. **Transfer** the remaining NVR to a clean, preweighed 30-ml beaker with watch glass. Next, using the filtered, distilled solvent, **rinse** the distillation flask three times, and **add** the rinses to the 30-ml beaker containing the NVR. *If, after adding the rinses,* the amount in the 30-ml beaker does not equal at least 20 ml, **use** the filtered, distilled solvent to continue rinsing the distillation flask and add the rinse to the 30-ml beaker until at least 20 ml has been collected.

4.8.3.8. Using the filtered, distilled solvent, **rinse** the clean watch glass and **cover** the 30-ml NVR beaker with the watch glass. **Transfer** the beaker to an oven set at no more than 2 deg above the distillation point of the solvent. **Leave** the beaker in the oven until all the solvent has evaporated.

Note: At this temperature, the NVR evaporates approximately 5 ml every 30 to 60 minutes. Total evaporation time is approximately 4 hours.

4.8.3.9. After all of the 20 ml has evaporated, **remove** the NVR beaker from the oven, and **allow** it to cool to ambient temperature.

4.8.3.10. **Weigh** the beaker. *If the beaker weight is negligible to the beaker preweight by comparison,* this is the final result. *If the beaker weight is not negligible to the beaker preweight,* **return** the NVR beaker to the oven for another 30 minutes.

4.8.3.11. After the additional 30 minutes, **remove** the NVR beaker from the oven, **allow** it to reach ambient temperature, and **weigh** it again. *If this weight is constant with the previous weight,* **subtract** the preweight of the NVR beaker from the final weight. The difference is the amount of NVR of the test article. **Repeat** the 30-minute oven bake procedure until the final weight is constant.

4.9 Data Recording and Reduction

EGL personnel shall perform the following procedures:

4.9.1. Tag-Reported Results: **Note** complete analytical results on a 3-in. by 5-in. paper tag. **Affix** this tag to the appropriate sampling point in a convenient location. Unless the order specifies otherwise or in the case of a time-critical sample, **tag-report** results on site within 24 hours of sampling. **Tag-report** points sampled on Friday no later than close of business (COB) on the following business day.

4.9.2. Daily Sample Log Sheets: See sections 4.2.23 and 4.3.33.

4.9.3. Weekly Report: **Compile** results from the daily sample log sheets on a weekly data report with a signature confirmation. **Provide** this report to the COTR no later than COB on Wednesday of the following week. The report covers work performed the previous week (Sunday through Saturday). The analytical results include data from analyses performed in the field, in the Building 4623 Chemistry Laboratory, and at clean benches.

4.9.4. AVO Reports: See section 7.1.

5.0 Notes

Custodians for EM10-OWI-CHM-052	
Master List and Document Control	EM10 Management Support Assistant
Alternate Document Control	EM10 Group ISO Representative
Records	Materials Test Branch ISO Representative
Calibration	Materials Test Branch Calibration Contact
Memoranda	Materials Test Branch ISO Representative

6.0 Safety Precautions and Warning Notes

6.1 Hazards

Warning
Death, severe personal injury, or loss of major equipment may result if maintenance or operating procedures, techniques, restrictions, etc., are not followed exactly.

The nature of Environmental Gas Laboratory testing involves several potential hazards. These include:

- Transporting compressed air cylinders
- Working with cryogenic liquids
- Lifting and moving sample containers
- Handling of hazardous chemicals
- Handling gas tight syringes
- Accessing high-pressure gas lines.

For further information about potential hazards related to pressurized gases, personnel **shall refer** to the following materials:

- *High Pressure System Safety* Training Manual
- *Cryogenics Safety* Training Manual
- Environmental Gas Laboratory Sample Collection videos.

6.2 Safety Precautions

EGL personnel **shall follow** the following safety precautions:

6.2.1. **Observe** normal laboratory safety rules.

6.2.2. **CAUTION:** When performing all sampling, **stand to the side** of the sampling port.

6.2.3. When testing in the Building 4623 laboratory, **plan** testing so that two Environmental Gas Laboratory chemists are in the test area or that one Environmental Gas Laboratory chemist is in the test area and one other alerted person is in Building 4623 during testing. For specific personnel requirements, **refer** to section 4.7, Personnel Control (Facility Management), of EM10-OWI-CHM-CHM-050, *Building 4623 Guidelines for Test Operations*. When analyses are performed in other buildings' laboratories, **plan** testing so that at least one other alerted person in is that building during testing.

6.2.4. In accordance with Occupational Safety and Health Administration requirements, **read** the Materials Safety Data Sheets (MSDSs) for all chemicals used or encountered during testing. **Read** the test material's MSDS to ensure familiarity with all safety precautions associated with the material. **Verify** that all Environmental Gas Laboratory personnel are aware of all highly hazardous, reactive, or toxic components of the test material.

6.2.5. **Wear** safety apparel appropriate for the test specimens and conditions:

- **Wear** safety glasses at both high- and low-pressure sampling points.
- **Wear** a face shield and cryo-proof gloves when sampling liquid nitrogen.
- **Wear** a face shield, cryo-proof gloves, and a non-static jumpsuit when sampling liquid oxygen and liquid hydrogen.
- **Wear** cotton gloves and a non-static jumpsuit when sampling gaseous oxygen and gaseous hydrogen.
- **Wear** hard hats when working in areas where hard hats are required.

Note: The wearing of ear plugs during sampling is optional for most sampling procedures. (**See** following note for the exceptional case.) When wearing ear plugs, **do not insert** the ear plugs until after completing the leak check, since most leaks are initially detected audibly.

CAUTION: Do not wear ear plugs when a sampling procedure calls for the use of watermelon sample cylinders.

6.2.6. When operating Environmental Gas Laboratory equipment, **refer** to the safety section of each operator's manual, located in the Environmental Gas Laboratory.

6.2.7. **Smoking is not permitted** in Building 4623. The test area is generally an oxygen-enriched environment. Open flames or other high-temperature sources are not permissible in the testing area while enriched-oxygen conditions exist.

6.2.8. **Verify** that no lights or sirens are on outside the Environmental Gas Laboratory before entering to ensure that the oxygen level indicated by the gauge reads between 19.5 and 23.5% oxygen.

6.2.9. When handling cylinders and dewars or when making connections for compressed gases and/or liquids, **refer** to *Working Safely with Compressed Gases and Cryogens, NSTC 313-Cryogenics Safety, and NSTC 315- High-Pressure System Safety.* (**See** the test engineer for these resources.) **Comply** with the suggestions inside these presentations.

6.3 Special Precautions Associated with Compressed Gases and Liquids

6.3.1. All operations involving the sampling of liquid hydrogen, gaseous hydrogen, liquid oxygen, or gaseous oxygen shall be performed by two or more technicians.

6.3.2. All operating personnel shall be instructed on the nature of hazards associated with compressed gases and liquids.

6.3.3. Before removal of any component of the system for servicing, the operator **shall secure** and **inspect** the system to ensure that no unsafe condition exists.

6.3.4. Because gases are typically collected from pressurized gas lines, and the possibility of an accident always exists, **notify** the facility contact before proceeding to the collection point. *If necessary,* have the facility contact or other gas lab personnel accompany you while collecting the sample. *If it appears that the gas lines have been altered (maintenance, leaks, etc.), environmental conditions are unsafe, or other conditions are present that make you uncomfortable,* **leave** the area and **collect** the sample later.

6.3.5. **Perform** continuous monitoring, *e.g.,* check operating pressures, look for leaks, listen for unusual noises, during all operations. Personnel **shall ensure** that oxygen leak levels are adequate throughout operations.

6.4 Emergency Shutdown Procedure

Not applicable; EGL equipment does not have to be shut down to be considered safe in an emergency.

6.5 Accident Reporting

6.5.1. From a safe location, the *test operator* **shall immediately call 911** and **shall notify** the EM10 Materials Test Branch Chief or the Environmental Gas Laboratory manager.

6.5.2. From a safe location, the notified *EM10 Materials Test Branch Chief/Environmental Gas Laboratory manager* **shall immediately report** the accident to the NASA Safety Monitor and the appropriate supervisor(s).

6.6 Emergency Response Plan

Emergency procedures and plans for Building 4623 are incorporated into the OWIs and are stated in MPR 1040.3. *MSFC Emergency Plan*. Plans **shall** be modified if operations change in a significant manner.

6.7 Mishap Reporting

"Each employee is responsible for reporting emergencies, unsafe or potentially unsafe conditions, mishaps and close calls in the workplace.[1]"

Environmental Gas Laboratory personnel shall:

Report all mishaps occurring in the Environmental Gas Laboratory in Building

[1] MWI 8621.1 *Close Call and Mishap/Incident Reporting and Investigation Program.* March 27, 2000. pg. 7.

4623 to the *EGL manager*, who shall **report** the mishap to the *area coordinator/ Safety Monitor*, who shall **report** the mishap or close call in accordance with MWI 8621.1, *Close Call and Mishap/Incident Reporting and Investigation Program*. Specifically,

- For all Type A & B mishaps, the *area coordinator/Safety Monitor* shall immediately **initiate** an initial verbal report to the Center Director and S&MA Director.

  Note for contractor employees: In the absence of the EGL manager and the area coordinator/Safety Monitor or other NASA employee, any employee is authorized to initiate verbal notification of the Center Director and S&MA Director immediately.

- For all mishaps and close calls, a flash report shall be generated within 4 hours of the mishap occurrence. The *employee reporting the mishap or close call* **shall notify** his/her supervisor immediately. The *employee's immediate supervisor* **shall call** 544-4357, Option 0, to generate the flash report. In addition, the *employee's immediate supervisor* **shall submit** NASA Form 1627 to S&MA within 6 calendar days. All mishaps **shall** be reported in accordance with MWI 8621.1, *Close Call and Mishap/Incident Reporting and Investigation Program.*

Mishaps or close calls that occur while performing Environmental Gas Laboratory analyses in facilities other than Building 4623 shall be reported to that facility's building manager or test engineer responsible for developing that facility's emergency procedures, in accordance with MWI 8621.1, *Close Call and Mishap/Incident Reporting and Investigation Program.* The *employee reporting the mishap or close call* **shall also notify** his/her supervisor immediately. The *employee's immediate supervisor* **shall call** 544-4357, Option 0, to generate the flash report. In addition, the *employee's immediate supervisor* **shall submit** NASA Form 1627 to S&MA within 6 calendar days. All mishaps **shall** be reported in accordance with MWI 8621.1, *Close Call and Mishap/Incident Reporting and Investigation Program*

7.0 Attachments, Data, Reports, and Forms

7.1 Attachments

7.1.1. Procedure for Avoid Verbal Orders (AVOs)

7.1.1.1. A customer telephones and requests service.

7.1.1.2. The contractor writes an AVO containing the following information:

- AVO number
- Requester's name
- Contract line item number
- Specifics (if applicable)
- Number of samples requested
- Sample location and identification number (if applicable)
- Contact person's name, telephone number
- Other essential information.

7.1.1.3. The contractor then assigns a technician to perform the AVO and gives the technician copy of the AVO.

7.1.2. Line Item descriptions. Figure 7.1-1 lists the Line Item numbers referenced in section 4.4 and provides a description of each.

7.2 Reports

The Weekly Report contains a compilation of all sample data collected on the AVO Test Request (Form EM10-F-CHM-036, Figure 7.3-2) and the Gases and Liquids Report Routine Orders (Figure 7.3-3). (See section 8 for additional information about the Weekly Report.)

7.3 Forms

7.3.1. Daily Sample Log Sheet. Figure 7.3-1 shows a representative sample of the Daily Sample Log Sheet.

7.3.2. AVO Test Request Form. Figure 7.3-2 shows a representative sample of the AVO Test Request Form.

7.3.3. Gases and Liquids Report Routine Orders. Figure 7.3-3 shows a representative sample of the Gases and Liquids Report Routine Orders form.

7.3.4. Calibration Sheet. Figure 7.3-4 shows a representative sample of the Calibration Sheet.

Figure 7.1-1.
Description of Environmental Gas Laboratory Line Items

Line Item #	Description
4	Evaluation of gaseous air for particulate, moisture, and total hydrocabrons according to MSFC-PROC-404
5	Evaluation of gaseous nitrogen for particulate, moisture, and total hydrocabrons according to MSFC-PROC-404
6	Evaluation of gaseous helium for particulate, moisture, and total hydrocabrons according to MSFC-PROC-404
7	Evaluation of gaseous argon for particulate, moisture, and total hydrocabrons according to MSFC-PROC-404
8	Evaluation of gaseous hydrogen according to MIL-P-27201 for nitrogen, moisture, volatile hydrocabrons, and oxygen plus argon; according to MSFC-PROC-404 for particle count
9	Evaluation of liquid hydrogen according to MIL-P-27201 for nitrogen, moisture, volatile hydrocabrons, and oxygen plus argon; according to contractor-selected method for particle count
10	Evaluation of gaseous nitrogen according to MIL-P-27401 for oxygen, total hydrocabrons, and moisture; according to MSFC-PROC-404 for particle count
11	Evaluation of liquid nitrogen according to MIL-P-27401 for oxygen, total hydrocabrons, particulate, and moisture
12	Evaluation of gaseous oxygen according to MIL-P-25508 for purity, moisture, total hydrocabrons, and acetylene; according to MSFC-PROC-404 for particle count
13	Evaluation of liquid oxygen according to MIL-P-25508 for purity, moisture, total hydrocabrons, acetylene, and particulate
14	Evaluation of gaseous helium according to MIL-P-27407 for oxygen, moisture, hydrocabrons, and impurities; according to MSFC-PROC-404 for particle count
15	Evaluation of high purity air (to be used as Breathing Air, Grad E in life support systems) according to ANSI/CGA G-7.1 foroxygen, carbon monoxide, and carbon dioxide; according to MSFC-PROC-404 for moisture, total hydrocarbons, and particulate; acccording to contractor-selected procedure for odor (using a safe sniffing procedure and describing any detectable odor) and a mass spectrometer scan to identify elemental constitutes of the sample and any odorus gases present
19	Evaluation of ultra high purity argon, analyzing for purity, oxygen, nitrogen, hydrogen, water, and total hydrocarbons according to Grade 5.0 contol limits
20	Evaluation of ultra high purity helium, analyzing for purity, oxygen, water, total hydrocarbons, carbon dioxide, and carbon monoxide, according to Grade 5.0 contol limits
23	Partial MSFC-PROC-404 on any gas for total hydrocarbons, particulate, or moisture

	Sample Pt.	Cyl #	Filter #	Moist	P30-100	P>100	Sample Type	O_2	CO_2	Total HC	Log #	Date
1												
2												
3												
4												
5												
6												
22												
23												
24												
	SPECIAL SAMPLES											
	AVO #	**Cyl #**	**Filter #**	**Moist**	**P30-100**	**P>100**	**Sample Type**	**O_2**	**CO_2**	**Total HC**	**Log #**	**Date**
1												
2												
3												
4												
5												
6												

Figure 7.3-1.
Daily Sample Log Sheet (sample)

Note: Representative Daily Sample Log. For Illustration only..

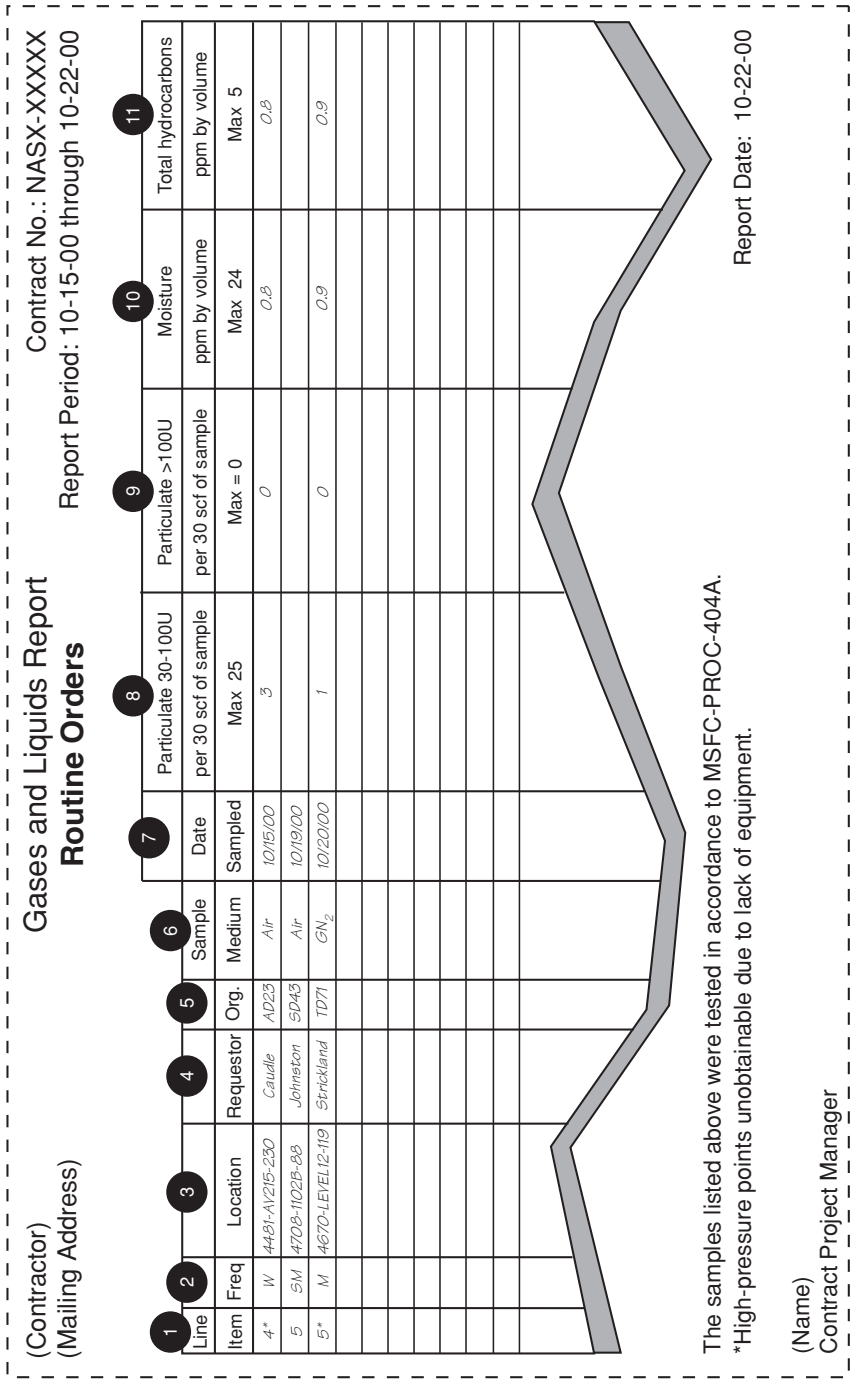
AVO # 027	Date 11-23-99	Requestor/Org/Ph Cooper/TD71/4-3544
Contract Line Item #	Specifics if Applicable	Number of Samples	Location, Sample ID#, Specification/Procedure (if not inherent to line item #) Other essential remarks.
5		1	TS 116
			Contact: Tommy Barron, LB4B, 4-1283
			① LOX line GN2 purge 50 psi max
			② ips supply line
			moisture, hydrocarbons – no particulates
Sampled by MSFC?			Env. Compliance Sample?

1/05 EM10-F-CHM-068

Figure 7.3-2.
AVO Test Request Form (sample)

Note: Representative AVO Test Request. Refer to Forms Master List for current version.

Figure 7.3-3.
Gases and Liquids Report
Routine Orders (sample)



(Contractor)
(Mailing Address)

Gases and Liquids Report
Routine Orders

Contract No.: NASX-XXXXX
Report Period: 10-15-00 through 10-22-00

1 Line	2 Item	Freq	3 Location	4 Requestor	5 Org.	6 Sample Medium	7 Date Sampled	8 Particulate 30-100U per 30 scf of sample Max 25	9 Particulate >100U per 30 scf of sample Max = 0	10 Moisture ppm by volume Max 24	11 Total hydrocarbons ppm by volume Max 5
	4*	W	4481-AV215-230	Caudle	AD23	Air	10/15/00	3	0	0.8	0.8
	5	SM	4708-1102B-88	Johnston	SD43	Air	10/19/00				
	5*	M	4670-LEVEL12-119	Strickland	TD71	GN_2	10/20/00	1	0	0.9	0.9

The samples listed above were tested in accordance to MSFC-PROC-404A.
*High-pressure points unobtainable due to lack of equipment.

Report Date: 10-22-00

(Name)
Contract Project Manager

1. Enter Line Item number.
2. Enter frequency of order: W = weekly; M = monthly; SM = semi-monthly.
3. Enter location of test (building number, room number, point number).
4. Enter last name of requestor.
5. Enter organization code of requestor.
6. Enter atmospheric medium of sample: Air, GN_2, GHe, etc.
7. Enter date sampling was performed.
8. Enter reading of particulates 30-100.
9. Enter reading of particulates >100.
10. Enter moisture reading.
11. Enter total hydrocarbons reading.

Note: Representative Gases and Liquids Report. For Illustration only..

Calibration Statement: Categories IV and V Equipment

Calibration is required before use per MPR-8730.5.

(Calibration before use for each test series and periodic testing by the Using LIne Organization)

Calibration Contacts: EM10/James Perkins, EM10/Mark Griffin

User Name:_____

Equipment Description:_____

(attach multiple components sheets if necessary)

Manufacturer:_____

ECN:_____ Serial No.:_____ Model No.:_____

Date of Calibration:_____

Type of Software and Version:_____

_____

Listing of Standards Associated with Calibration:

_____

_____

_____

_____

_____

Are standards National Institute of Standards and Technology (NIST) traceable? ☐ Y ☐ N

Did calibration meet equipment manufacturer's specifications? ☐ Y ☐ N

Calibration was performed by:_____

Remarks:

_____

_____

_____

_____

_____

_____

_____

_____

1/05 ED36-F-CHM-018

Figure 7.3-4.
Calibration Sheet (sample)

Note: Representative Calibration Sheet. Refer to Forms Master List for current version.

8.0 Records

Records for the Environmental Gas Laboratory shall consist of (a) memoranda that contain test results and that are stored electronically in the Materials and Processes Technical Information System (MAPTIS) and (b) calibration records.

8.1 Memoranda

Memoranda containing test results shall be retained indefinitely by EM10. These memoranda shall be stored electronically in the MAPTIS database and shall be accessible by test request number or memorandum number.

A weekly record of all Environmental Gas Laboratory analyses, which contains all sampling sites and the results obtained, shall be compiled by laboratory personnel and presented to the NASA COTR. The COTR shall maintain the document indefinitely.

8.2 Calibration Records

8.2.1. All equipment requiring calibration shall be in current calibration, in accordance with EM10-OWI-CHM-CHM-050, *Building 4623 Guidelines for General Operations*.

8.2.2. Form EM10-F-CHM-018, current revision (Figure 1, section 7.0), shall be used to document the calibration of all Category IV and Category V equipment. For each laboratory instrument used in the Environmental Gas Laboratory, a record of calibration performed (Category IV/V Calibration Sheet, Form EM10-F-CHM-018, Figure 7.3-4) shall be maintained in a notebook in close proximity to the instrument.

8.3 Maintenance of Records

8.3.1. Memoranda less than 10 years old shall be maintained in ready-access files in MAPTIS; memoranda 10 years old or older shall be automatically transferred to historical files.

8.3.2. Calibration records shall be maintained on site for a minimum of 10 years, filed and indexed by test request number. These shall be stored in a manner that will protect them, *e.g.*, in a test folder stored in a metal file cabinet. After 10 years, calibration records shall be transferred to historical files.

8.3.3. The original test records shall be saved for a minimum of 5 years.

9.0 Tools, Equipment, and Materials

9.1 Testing Equipment

9.1.1. Perkin-Elmer Autosystem GC: A gas chromatograph with a flame ionization detector (FID) and a capillary RTX-1 polysiloxane column for analysis.

9.1.2. MTI GC : A portable two-channel gas chromatograph equipped with thermal conductivity detectors (TCDs) and two short capillary columns for analysis.

9.1.3. Finnigan GC/MS INCOS 50 XL: A gas chromatograph that uses a quadrapole mass spectrometer as a detector, a capillary column for separation, and a Tekmar purge and trap for sample concentration.

9.1.4. Shaw moisture meter: A portable on-site meter with a molecular sieve hygrometer. Instrument detects ppm moisture in gas samples.

9.1.5. Fisher Scientific Micromaster Microscope: A binocular microscope used for particle counts.

9.1.6. RGA5 Process Gas Analyzer: A gas chromatograph equipped with two chromatographic columns and two detectors (FID and reduction gas detector). Instrument is optimized for detection of gaseous samples at trace levels.

9.1.7. Gow-Mac 580 GC: A gas chromatograph equipped with two chromatographic columns and one discharge ionization detector (DID). Instrument is optimized for detection of gaseous samples at trace levels

9.1.8. Agilent 6890 GC: A gas chromatograph equipped a chromatographic column and one pulse discharge detector (PDD). Instrument is optimized for detection of gaseous samples at trace levels.

9.2 Required Tester Maintenance

When Gas Laboratory equipment requires repair or maintenance, **notify** the Environmental Gas Laboratory Manager.

9.3 Calibration

Table 9.3 shows the calibration schedule for other Environmental Gas Laboratory instruments.

Table 9.3.
Calibration Schedule

Instrument	Calibration Schedule	
	Before Analysis	Other
PE Autosystem GC	✓	
MTI GC	✓	
Finnigan Voyager GC/MS	✓	
Fisher Microscope		Not required
RGA5 Process Gas Analyzer	✓	
Gow-Mac 580 GC	✓	
Drager Tubes		Certified by lot number
Certified Gas Standards		Replaced depending on expiration date. Certified within x percent of the requested value by an outside vendor.

9.4 Environmental Gas Laboratory Equipment

Table 9.4 lists the Environmental Gas Laboratory instruments.

Table 9.4.
Environmental Gas Laboratory Equipment

Item Description	NEMS#/Model#	Location	Room
Gow-Mac 580 Gas Chromatograph	1965738	Bldg. 4623	102
Trace Analytical RGA5	1965438	Bldg. 4623	102
Tekmar 3100 Purge and Trap Concentrator	2014752	Bldg. 4623	102
Finnigan GC/MS INCOS 50 XL	1281763	Bldg. 4623	102
CE Instruments GC8000 TOP Series	1937593	Bldg. 4623	102
Autosystem Gas Chromatograph/FID	1219430	Bldg. 4623	102
Microsystems Technology Inc. M200D GC	1397789	Bldg. 4623	102
Microsystems Technology Inc. M200D GC	1401222	Bldg. 4623	102
Fisher Scientific Micromaster Microscope	1962938	Bldg. 4623	102
Drager Tube Kit	accuro	Bldg. 4623	102
Shaw Dewpoint Meter	1964784	Bldg. 4623	102
Shaw Dewpoint Meter	1964783	Bldg. 4623	102
Cosmodyne Cryogenic Ssampler	535744	Bldg. 4623	102
Cosmodyne Cryogenic Sampler	535743	Bldg. 4623	102
Cosmodyne Cryogenic Sampler	547323	Bldg. 4623	102
Cosmodyne Cryogenic Sampler	535739	Bldg. 4623	102
High-Pressure Sampling Cylinder (500-ml capacity) (24)	N/A	Bldg. 4623	102

10.0 Personnel Training

The nature of work that occurs in the Environmental Gas Laboratory is complex and involves potential hazards; therefore, all environmental gas activities covered by this OWI shall be performed only by credentialled Environmental Gas Laboratory personnel or under the direct supervision of personnel credentialled to do this work.

Because of the complexity and variety of tasks covered in this OWI, credentials have been broken down into the following areas:

1. Low-Pressure Gas Monitoring
2. High-Pressure Gas Monitoring
3. Cryogenic Monitoring
4. Laboratory Analysis of Gasses
5. Sampling and Laboratory Analysis of NVR content

Credentialling in each of these areas **shall comply** with MWI 3410.1 and other appropriate training:

- Training in the following subjects:
  - Cryogen Handler (Areas 2, 3)
  - High Pressure Systems (Areas 2, 3, 5)
  - Hydrogen Handler (Areas 1, 2)
  - Inert/Asphyxiate Gases and Liquids (Areas 1, 2, 3, 4, 5)
  - Oxygen System Handler (Areas 1, 2, 3, 4)
  - Oxygen System User (Areas 1, 2, 3, 4)
  - General Safe Laboratory Practices (Areas 1, 2, 3, 4, 5)
  - Hazardous Waste Disposal (Area 5)
  - OSHA Hearing Conservation Training (Areas 1, 2, 3, 4, 5)
  - Respirator Training (Area 3)
  - Marshal Contractor Safety Forum Training (Areas 1, 2, 3, 4, 5)
- Reading of the OWI thoroughly and signing a statement of reading and understanding the OWI. Each candidate shall be issued a personal copy of the OWI.
- Passing a written test (minimum grade of 70) covering the entire OWI, administered by the test engineer. This test shall consist of multiple choice questions and be given as an "open OWI test". A maximum of 1.5 hours shall be allowed to complete this test.

If a credentialled person is not available for training candidate personnel, the EGL contractor supervisor shall work with the NASA counterpart to credential a qualified field person.

When a person has been credentialled, the supervisor shall provide credentialling documentation, including a card for the person to carry. Records shall be kept on file with other training records as proof of training. These records shall include training expiration dates and required refresher courses. Verification of credentials

shall consist of a copy of the written test, the signed statement, and the training record. The contract project manager shall inspect these records and issue 2-year certification cards.

In addition to the above requirements, each specific credential shall require that the following additional requirements be met:

10.1 Low-Pressure Gas Monitoring

1. The candidate shall have a minimum of 2 years of technical college training or 4 years of relevant technical experience.

2. The candidate shall read and become familiar with MSFC-PROC-404. Questions from this document shall appear on the test mentioned below.

3. Test Area access training. This is required because many points are located in the test area.

4. Training in the use of the instruments and sampling gear used for this work by credentialled EGL personnel or other qualified personnel: This training shall take place in the field and shall require a minimum of 10 days, during which the candidate shall travel with a credentialled person performing this work.

5. Demonstrating knowledge of the tests and monitoring equipment by completing 10 successful test sets under the supervision of the test engineer or credentialled EGL personnel.

6. Demonstrating knowledge of the tagging procedure and the location of weekly, monthly, and other points.

7. Passing a written test (minimum grade of 70) covering the Low- Pressure Gas Monitoring portions of the OWI, administered by the test engineer. This test shall consist of essay-type questions and be given as a “closed OWI test.” A maximum of 1 hour shall be allowed to complete this test.

10.2 High-Pressure Gas Monitoring

1. The candidate shall have a minimum of 2 years of technical college training or 4 years of relevant technical experience.

2. The candidate shall be credentialled for Low-Pressure Gas Monitoring

3. Training in the handling of compressed gas cylinders.

4. Training in the use of the instruments and sampling gear used for this work by credentialled EGL personnel or other qualified personnel. This training shall take place in the field and shall require a minimum of 10 days, during which the candidate shall travel with a credentialled person performing this work.

5. Demonstrating knowledge of the tests and monitoring equipment by completing 40 successful test sets under the supervision of the test engineer or credentialled EGL personnel.

6. Demonstrating knowledge of the tagging procedure and the location of weekly, monthly, and other points.

7. Passing a written test (minimum grade of 70) covering the High- Pressure Gas Monitoring portions of the OWI, administered by the test engineer. This test shall consist of essay-type questions and be given as a "closed OWI test." A maximum of 1 hour shall be allowed to complete this test.

10.3 Cryogenic Monitoring

1. The candidate shall have a minimum of 2 years of technical college training or 4 years of relevant technical experience.

2. The candidate shall be credentialled for Low-Pressure Gas Monitoring

3. Training in cryogenic fluid handling.

4. Training in use of the instruments and sampling gear used for this work by credentialled EGL personnel or other qualified personnel. This training shall take place in the field and shall require a minimum of 10 days, during which the candidate shall travel with a credentialled person performing this work.

5. Demonstrating knowledge of the tests and monitoring equipment by completing 20 successful test sets under the supervision of the test engineer or credentialled EGL personnel.

6. Demonstrating knowledge of the tagging procedure and the location of weekly, monthly, and other points.

7. Passing a written test (minimum grade of 70) covering the Cryogenic Monitoring portions of the OWI, administered by the test engineer. This test shall consist of essay-type questions and shall be given as a "closed OWI test." A maximum of 1 hour shall be allowed to complete this test.

10.4 Laboratory Analysis of Gasses

1. The candidate shall possess a B.S. in chemistry or other 4 year technical degree or have an equivalent in experience in the laboratory.

2. Formal training by an instrument's manufacturer or other qualified personnel for all required analytical instruments.

3. Training in cryogenic fluid handling

4. Training in handling of compressed gas cylinders.

5. Demonstrating knowledge of the tests and Environmental Gas Laboratory equipment by completing two successful test sets under the supervision of the test engineer.

10.5 Sampling and Laboratory Analysis of NVR Content

1. The candidate shall possess a B.S. in chemistry or other 4-year technical degree or have an equivalent in experience in the laboratory.

2. Training in the field by a credentialled EGL person for 10 days.

3. Demonstrating proper sampling under the supervision of a credentialled EGL person.

4. Training in the laboratory by a credentialled EGL person for 10 days.

5. Demonstrating proper NVR analysis under the supervision of a credentialled EGL person.

6. Passing a written test (minimum grade of 70) covering the NVR portions of the OWI, administered by the test engineer. This test shall consist of essay-type questions and shall be given as a "closed OWI test." A maximum of 1 hour shall be allowed to complete this test.

10.6 Recredentialling

After 2 years, credentials shall expire, and recredentialling shall be required. Recredentialling shall be granted automatically *if there has been no break in service over 6 months and if the candidate has been performing duties in the credentialled area continuously. If a break in service has occurred for over 6 months,* the candidate shall repeat the entire credentialling process, including testing.

This page is deliberately blank

EMERGENCY PHONE NUMBERS

Emergency..... 911

Medical Center..... 4-2390

Industrial Safety..... 4-0046

Chemical Spills..... 4-4357

Safety Monitor
Building 4623..... 5-0358